



TRANSFORMATIONS DETERMINED BY THE EMERGENCE OF TECHNOLOGY IN THE OUTER SPACE

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The discovery of unknown aspects of outer space has become one of the most important goals in our world, due to the benefits, we have in our daily lives, both through the technology launched in space and through human curiosity to conquer new territories. The great powers of the world are looking for solutions for the development of space technologies both to increase economic power and to ensure military supremacy. This can lead to the development of technology, to ensure huge amounts of data and information, fast, complex and useful connections in all areas of military and civilian activity.

Keywords: technology; artificial intelligence; satellites; navigation; communications; intelligence; outer space.

Introduction

The state of space research is highly developed, but expensive and therefore accessible only to highly developed countries. The topic of the article is not a novelty, but represents a permanent subject of study due to technological development and the expansion of military activities in outer space. It is expected that in the near future most countries in the world will have access to research programs, either on their own or in cooperation, in order to be able to launch their own satellites and reap their benefits for much lower costs. Space technology makes possible the study of the atmosphere, water and land in detail, ensuring the fast transmission of impressive amounts of data and offers the possibility to develop useful navigation applications for all the areas of social life.

Originally created for military purposes, space technology has become an indispensable utility in all the areas of activity and continues to develop in order to ensure the security of the world's borders, to improve the daily life of mankind, to modernize technology and to protect the planet. Given the limited space available in this article, I will try to answer questions such as: Does the development of science and technology make space a battleground for the great powers? Is there a theater of operations in which the fight takes place with space technologies? Is space a new operational field? What are space objects and

what do we need to protect them?

According to the *Romanian Military Strategy* of 2021, the characteristics of the operating environment imply, among other things, "the creation of capabilities specific to the new fields of military operations (cyberspace and outer space)" (Romanian Government 2021, 9). Outer space is already considered a new operational field in the United States of America and represents a concern for highly developed countries such as Russia, China, Israel, Japan, Germany, France etc.

Romania is interested in "developing smart technologies aimed at economic growth and job creation" in all the areas of civilian activity (Gheorghiu, et al. 2020). *The Romanian Space Agency* "represents the Government of Romania in international space cooperation programs and coordinates the National Space Program" (ROSA 2021).

The study of outer space and the possibility of using it for civilian and military purposes leads to the analysis of theoretical implications that may influence knowledge of this field and the possible opportunity for Romanian Army specialists to be involved in programs initiated within NATO and EU. Space technology represented by launch systems, satellites and orbital stations has the role of providing data and information for the development of terrestrial applications extremely useful for improving living conditions on the globe.

Satellite navigation is a technology that allows users around the world to establish their position at any time. Satellite positioning systems were originally used for military applications, in

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the construction of "smart bombs", to improve targeting in order to reduce the collateral casualties. The possibility of providing global satellite positioning services implies, for the countries that own these systems, the possibility to stop the services in certain areas; thus they have the power. I could say that in space there is a "theater of operations of satellite systems" which can be improved in order to create a new phenomenon called operational environment, similar to land, air or naval. As a result, it is imperative to carefully analyze outer space, focusing not only on the development of technology but also on its protection, by keeping track and creating programs to monitor and alert those who produce, launch and use satellites and adjacent equipment.

It is expected that our entire social, economic and political life will change in the same fast pace with technology development. The national defense system will be strongly influenced by new technologies starting with the planning and decision-making process, the stages of preparation for military conflicts and last but not least, the management of actions carried out both inside and outside the national territory.

In the not too distant future, technological supremacy due to the benefits of using satellite systems could ensure strategic supremacy, by discouraging small countries without economic power.

Outer space - the battle arena of the great powers

People have always looked at the sky, using the sun and the stars for orientation, for navigation, but this becomes much more important, even vital, when it comes to a soldier moving in unknown enemy territory. Locating his position can be the most important thing for him, because it can make the difference between life and death, between victory and defeat. With the evolution of science, we began to replace "celestial bodies with artificial satellites, so that navigation has become an activity accessible to a growing audience, which does not require controlled and verified qualification on various phases and points of movement, both possible during the day as well as at night" (Luparu 2011).

In the military field, "new technologies will change the nature of war" (Romanian Government

2021, 7), taking as an example the best-known satellite navigation system, *Global Positioning System* (GPS), originally designed for military use, later providing technological support for the development of most smart technology-based applications by accessing the location of satellite-connected devices. How did we get here?

With the launch of Earth's first artificial satellite, called *Sputnik 1*, on October 4, 1957, man demonstrated to himself an extraordinary ability to operate beyond Earth's boundaries, as well as his astonishing ability to explore the world around him, understand and use its possibilities. The launch of this satellite was made possible not only by the thirst for knowledge, but also by the development of military power and the preparation for a new possible threat.

Since the early 1960s, the Union of Soviet Socialist Republics (USSR) and the United States of America (USA) have tried to place nuclear weapons in geostationary orbit in order to have permanent control over their opponent's territory. Later, this desire was abandoned because intercontinental missiles were just as effective, since World War II, Germany using V-2 self-propelled missiles, then considered long-range. This represented the basis of the revolution in space exploration.

Due to the cooperation with the USSR, in May 1981, Romania participated for the first time in a space mission, by sending the aeronautical engineer, lieutenant-major Dumitru Prunariu, on the ship *Soyuz - 40*. It flew in space for 7 days, 20 hours, 42 minutes and 52 seconds, where he obtained very valuable information in the field of astrophysics, the study of radiation, technology, biology, medicine and psychology. Thus, our country has entered the select world of those who explore the universe and fly among the stars.

For the command and control of military forces in space, the United States established the *United States Space Command* (US SPACECOM), initially in 1985 (Popescu 2022), inactivated in 2002 and re-established in 2019, with the mission to "conduct operations in, from and through space, to discourage conflict and, if necessary, to combat aggression, to provide space combat power for the joint / combined force, and to defend vital US interests with allies and partners" (United States Space Comand 2018).



The established objectives of this command are to: understand competitors, build a high-performance command and control team, maintain cooperative relationships, digital superiority, trade integration and the collaboration of intergovernmental organizations. It is understandable that the organization, missions and projects established within this institution are desired by the whole world interested in the new dimension created, the space operational environment. In 2020, the US has developed a space defense strategy for the next 10 years, which clearly sets out the lines of effort to be achieved.

China has kept pace with technology in order not to lose ground in the race for space development, making major investments in intercontinental ballistic missiles and launching its first space flight in 2003 with the *Shenzhou* spacecraft. The mission made China the third country in the world to successfully send humans into space (China Space National Administration 2021)

Israel has been able to actively participate in the development of space technology for both civilian and military use through the construction of satellites and unique technologies (Israel Space Agency 2022).

Given the progressive development of space technologies aimed at both civilian and military purposes especially by increasing the effectiveness of intercontinental ballistic missiles, the great powers have invested and continue to spend huge amounts of money on the development of such actions. The tendency of outer space to become the fourth dimension of war is no longer just a probability, in the future will certainly have a decisive influence on world peace.

The world's most economically developed countries are interested in investing in space technology to become a noteworthy military power, to raise the level of trust placed by society, to detect possible nuclear explosions and laser-powered weapons that, at this time exist being created independently of the will of the majority.

In my opinion, it is anticipated that in the next 50 years, outer space will become the battlefield of the great powers, given the rapid development of technology as a result of scientific research aimed at modernizing and simplifying life on planet Earth.

The "theater of operations" of satellite navigation systems

Today, worldwide, technology offers a wide range of applications in many fields, from traditional transportation, scientific research, tourism, mapping to communication and more. „A prosperous economy depends on at least one of the following: profit motivation, ground warfare, or space warfare" (Tyson and Lang 2020, 16). Here is how interest in space can develop the economies of countries around the world, regardless of size and political power. The desire to use space technology, on which the operation of voice and data communications depend, the use of hardware devices, navigation of any kind, as well as terrain observation at any point, is common to all, but is realized only if the decision-making power of the world identifies ways to support and fund satellite launch programs and create the infrastructure needed to use them in areas of interest on Earth.

Currently, powers such as the USA, Russia, China, Israel, India, Great Britain, Japan, Australia, Spain, France, Germany are part of the select club of those who explore outer space. It is normal for the investments made to be covered by the benefits, so it is interesting to study the involvement of the countries of the world for economic development and maintaining military supremacy.

How satellites are used depends on their type, so it is interesting to know how they are classified and what they can bring to life on the planet. Depending on the destination, they can be: communications, navigation, weather determination, earth observation, scientific, military, reconnaissance, etc.

Communications satellites act as "amplification stations that provide point-to-point, point-to-multipoint, or interactive multipoint services and can be GEO (geostationary earth orbit) or LEO, MEO, or HEO (lower, medium, or highly elliptical orbit). The application area of this type of satellite mainly includes the transmission of television signal, international telephone services and data communications" (RF Wireless World, n.d.) (SlidePlayer, n.d.).

GEO satellites are launched into orbit, above the equator, at an altitude of 35,786 km, with the role of ensuring communications of any kind, given that for 24 hours they have direct visibility on a point on Earth.



LEO satellites are located between 500 and 1500 km above the Earth, make a complete rotation in 24 hours and have visibility for 15 minutes on a fixed point, ensuring the continuity of the transmission by placing them in several orbits. They have low costs but the lifespan is a maximum of 1 year.

MEO satellites orbit the Earth around the equator and the poles at distances between 5,000 and 12,000 km, with direct visibility with fixed points between 120 and 360 minutes. They are used for voice and data communications and have average costs.

HEO satellites are located at the perigee or apogee from Earth, which means that at the apogee they are at a great distance from the planet, 40,000 km and are used for communications and remote sensing coverage at high latitudes especially for polar areas.

Navigation satellites are used to determine the position of objects on Earth and are the basis for the development of applications used by mobile phones, hardware devices and other equipment and systems.

Weather-determining satellites have equipment for transmitting certain data resulting from the analysis of the earth's surface and atmosphere to ground stations, which through a process of mathematical analysis, provide vital information for predicting the weather for long periods of time.

The observation satellites can be civilian or military and are located at a distance of 700-800 km above the Earth, intended to obtain data on the state of the earth, seas and oceans and last but not least, on the military tactical situation necessary to maintain security and peace on the planet.

Scientific satellites are used for the study of other planets, comets, stars, galaxies, and especially to study the Sun and Moon.

Military satellites transmit coded data urgently needed to locate units, subunits, and military conflicts.

Reconnaissance satellites are intended primarily for military use as they provide data on friendly or enemy weapons, the extent of threats and other secret information needed to maintain international security and safety.

The analysis of the types of existing satellites show us their complexity and the need for the development of life on Earth and can determine our curiosity to find out how it got here.

The first nation to develop a global positioning system were the United States. Originally called the *Navigation Signal Timing and Ranging Global Positioning System* (NAVSTAR GPS), the Global Navigation Satellite and Radio Navigation System, originally designed for military purposes in the 1960's, has also been used for civilian purposes since 1983. GPS is now a system consisting of satellites capable of transmitting detailed information to develop applications in all the possible areas of activity.

Russia developed the *Global Navigation Satellite System* (GLONASS), a radio-based satellite navigation system in 1976, and is now operated by the Air Force. Since 1982, many missiles have placed satellites in the orbit system, until the desired constellation was completed in 1995. After the collapse of the USSR, the system crushed due to both confusion and economic collapse. The satellites deteriorated due to lack of funds, creating gaps in coverage, which led the Russian government to take the decision to restore the system by increasing their number.

The European Union (EU) has developed the GALILEO satellite navigation system since 2008, for quasi-total surveillance of the planet, the program being developed by the *European Geostationary Navigation Overlay Service* (EGNOS) in collaboration with the US GPS navigation system. This system has made it possible to improve the determination of the position up to 1 meter, as well as the transmission of integrity messages if the satellites come out of operation.

GALILEO has become a flagship project, both in terms of its strategic value and its important contribution, giving concrete shape to the EU's political, economic and technological dimensions since 2010. It has been designed and developed as a non-military application, even if it incorporates all the features necessary for protection and security. Unlike GPS, which was originally designed for military purposes, GALILEO provides a very high level of continuity for some of the services offered, based on the same technology as GPS. It offers a similar or higher degree of accuracy due to the structure of the satellite constellation, ground control and planned management systems.

The GALILEO navigation system offers high fidelity, as it includes a signal for "message integrity" (The European Space Agency, n.d.),



informing the user of any errors. Unlike GPS, it will be possible to receive GALILEO in cities and regions at extreme latitudes. Using the GALILEO system, integrated with other technologies, provide benefits to users, such as: an advanced level of air, road, rail and naval navigation, reduced travel time, increased confidence in group management and asset tracking in all areas, and more information for traffic tracking.

China has developed the *BEIDOU Satellite Navigation System*, in translation "the big chariot", at the end of the 20th century, for economic and social development, use in transportation, agriculture, forestry, fishing, hydrological and meteorological monitoring, natural disaster prevention and critical infrastructure monitoring (BeiDou Navigation Satellite System, n.d.).

India has built the *Indian Regional Navigation Satellite System* (IRNSS) which has been operating since 2012, all in its own right and is noted for being cheap on the world market. Other states are joining it, given the price, as well as the possibility that at some point it will be integrated into the Russian GLONASS system.

Japan has created the *Japanese Quasi-Zenith Satellite System* (QZSS) only from three satellites designed for mobile applications use for audio, video, data and navigation communications (Quasi-Zenith Satellite System, n.d.).

In 2012, Romania launched into orbit the first Romanian nanosatellite, called GOLIAT, "CubeSat type, being considered both a prototype and a platform for exploring the environment near Earth" (The European Space Agency, n.d.), in order to receive high-resolution images, radiation dose measurements and micrometeorite flux information as well as for the transfer of data to ground stations, which are necessary for scientific analysis and dissemination. Although it was not a success, due to the fact that the embedded devices could not be turned on, and in 2015 it burned with the re-entry into the atmosphere, it is worth noting the involvement of the Romanian Space Agency in joint projects with the *European Space Agency* (ESA) and cooperation with the *Space Research Committee* (COSPAR) for the development of new space capabilities.

Here is the hypothesis from which space technology can create a "theater of operations" is as explicit as possible, by presenting the ongoing concerns of scientists for supremacy, knowledge

of the universe and ensuring the safety of life on Earth. Where can we go and why do we need to be active to know the space? The answer to this question can be found right here.

First of all, because the information obtained by satellites is introduced into modern military control systems, it is used in the ground infrastructure development industry through software programs that establish the coordinates of works, activities in the area and provide quality services on navigation and transportation of any kind and instant communications.

Secondly, because a modern society uses the benefits of space technology to develop economies based on electronic and computer expertise, by providing high-performance communications and information services.

Satellite technology, which ensures the transmission of a large amount of data and information almost instantly, has a huge impact on human activity, social, economic, military, etc. as well as the whole of modern society. What are the advantages of those who have invested and are investing in space technology?

One of them is the development of applications based on the use of information received from satellites. They contribute to the improvement of human life by reducing intellectual and physical effort and last but not least by increasing the conditions necessary for the survival of the planet as long as possible, by monitoring climate change, geography, military activities, etc.

Another important advantage is the multinational collaboration that determines the use of the intelligence of the society's elites, the development of science, military power as well as the defense capacity of the states involved in the research and use of space resources.

Space technology saved lives during this difficult period of the COVID-19 pandemic by providing satellite monitoring, tracking services and specific devices tailored to decontamination and ventilation needs. Applications based on space technologies such as telecommunications, Earth observation, positioning and navigation, teletransmission and remote control, substantially address the economic challenges of today's society.

In this context, I appreciate that space technology is urgently needed for the development of life on Earth and regardless of concepts and

prejudices will be important to act to understand and reap the benefits of actively participating in increasing and understanding the "space theater".

Protecting space technology

Unidentified objects from space travel for years at speeds of about 27,000 km/h, so the destruction of a man-made satellite system can occur at any time and can cause major malfunctions, creating functional problems with navigation, communications, Earth observation and world economy. As a result of this possible fact, the evidence and protection of space technology has become a permanent concern of powerful states, by creating institutions specifically designed to ensure the security of the world.

EU Satellite Center – EU SATCEN is a Spanish-based institution established in 1992 in Torrejon de Arhez "to support the European Union's decision-making process, foreign and common security policy actions, in particular the Common Security and Defence Policy (CFSP), including the European Union crisis management missions and operations, by providing products and services resulting from the exploitation of relevant space assets and collateral data, including images from satellite and aerial imagery, and related services" (European Union Satellite Centre 2022).

Under the leadership of a Romanian engineer, Sorin Ducaru, the EU SATCEN staff made a catalog of evidence of space objects, necessary for awareness of the space situation and surveillance of known objects in the universe. Eight European countries joined the catalog: France, Germany, Italy, Great Britain, Poland, Portugal, Romania, Spain. The center's staff also created three important functions: tracking, processing information, and providing services.

The tracking function is achieved by placing a network of 50 sensors including radars, telescopes and laser telemetry stations that monitor and track space objects.

The information processing function ensures the coordination of data and the analysis of thousands of daily measurements resulting from different operational centers located on all continents, in order to keep track of space objects.

The service provider supplies information to registered users on a daily basis through the online portal created, about the avoidance of collisions

regarding possible collisions between space stations or between them and other unknown solid particles and generates products to help users avoid collisions. Also, in case of accidents, data can be obtained about the resulting fragments or analyzes can be obtained regarding the time range and the location of a possible impact of uncontrolled space objects re-entering the Earth's atmosphere.

"More than 140 cosmic objects belonging to EU Member States – civilian, military or commercial – are protected from the risk of collision in conditions of exploitation of all orbits" (Pascal, n.d., 3), which demonstrates the interest shown to the institution and the important role it plays in protecting the cosmic environment.

The United States considers outer space to be an operational field, with the establishment of the *Space Forces Command*, and is directly involved in both the development and monitoring of space technology and its protection. It is no coincidence that Pentagon politicians and planners are primarily concerned with gathering information and finding defense solutions for all the satellite-dependent defense systems.

Protecting space technology by creating technologies to avoid or warn about collisions, and to eliminate waste is extremely important and has become a permanent concern of the world's states that manage satellites and more. These actions also lead to the creation of new job opportunities for the world's industry, and the support of the Romanian elite of scientists, military engineers must be directed to this field.

Conclusions

The need and importance of studying the implications that space has had and has as an initiating factor, present and future, in the development of modern technology, as well as a new military operational field, is an extremely important fact throughout the world.

The field of cosmic activity has become vital, both for television, radio, telephony, data communications and for the creation of defensive capabilities absolutely necessary in the context of modern warfare. The most widespread variant of space technology is represented by communications satellites which are a pressing necessity for the whole society, resulting in remote sensing by remote analysis of the earth's



crust, of surface phenomena through various images of electromagnetic spectra. Also, the space technology applied in medicine, ensures the remote transmission, between hospitals of some data, of some information, absolutely necessary for the performance of surgeries or of another nature.

Outer space is becoming a battleground of the great powers, being permanently present in the daily life of mankind and is a wide subject of analysis, on the political agenda of governments and international organizations. The dependence of our civilization on space systems is already proven and becomes critical if we think about how much we depend on it by using intelligent technologies: computer, television, telephone. The COVID-19 pandemic affected all major human activities and had serious effects on the development of space-related technologies. However, research has continued, and the benefits of space technology have provided effective tools for crisis relief and management.

The Romanian Army benefits daily from the advantages of space technology by using encrypted communications and transmitting information in real time. With advanced technologies and adequate support, the changes of relief, strategy, infrastructure, industry, etc. are constantly updated. Information means power and why not, military supremacy, and those who create it know that!

Romania is a party and strengthens the strategic partnership with the USA, in order to be part of the developed programs and the benefits regarding the development of the knowledge of military specialists in space by participating with personnel in working groups, conferences and programs organized at NATO and EU level. The desire to reach the world of countries that explore the unknowns of space can become a reality, if we want it and if we eliminate the premise of high

costs. The benefits resulting from the creation of space technology can cover the costs and also lead to respect, security and involvement of the great powers in all the areas of activity from our country. The younger generation is and can be the beneficiary of the interest shown by scientists now, in the development of science and the implementation of modern programs in today's technology.

It is expected that space technology will provide so much information to Earth's activities that, in the future, modern technologies created on the basis of artificial intelligence, which is now in its infancy, will be able to create ways to prolong life, provide relief for people from intense intellectual effort, stress and difficult or strenuous physical activity.

Digital transformation can be the global engine of sustainable growth and could be a key lever in combating climate change by stimulating private investment and accelerating the implementation of resilient high-capacity infrastructure. The enthusiasm of the creators of new technologies is based on actions that will revolutionize systems based on the speed of transmission and the amount of data, will open the gateway to robotics and artificial intelligence. All equipment and technology will be replaced step by step, data transfers being so far the main barrier to advancing science. Areas such as medicine, economics, education and, above all, the military will benefit from radical transformations, and people will be different in their ability to adapt, understand and use new technologies for civilian purposes.

Scientific progress is unstoppable, perhaps has immeasurable limits, and our mission is to develop science in the interest of mankind, to live in prosperity, in peace, and to enjoy all that is most beautiful in our lives.

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